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ABSTRACT

The Science and Mathematics Education Centre (SMEC) at the Western Australian Institute of Technology offers two graduate courses: Graduate Diploma in Science Education and the Master of Applied Science (Science Education). Three distinct groups of students engaged in these SMEC programs can be identified based on their interests/expertise in computing and computer education: science/mathematics teachers with interests/expertise in areas other than computing or computer education, science/mathematics teachers who wish to develop expertise in computer education, and computer specialists who wish to pursue further studies in this area. Three computing components have been developed to meet the needs of students in each of these groups. One component deals with computer science and computer education. Units emphasized in this component include all areas of computer science from programing to computer architecture as well as computer assisted instruction and instructional design. Another component focuses on the computer as a tool in educational research while a third component deals with research and evaluation in computer education. Each of these components and the audiences they serve are discussed. A strategy for teaching computing skills as a tool in educational research is also considered. The strategy includes having teachers work on relevant and realistic tasks. (JN)

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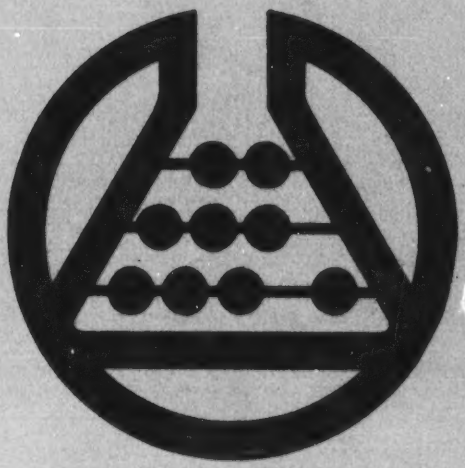

SCIENCE & MATHEMATICS EDUCATION CENTRE

TECHNICAL REPORT SERIES

Technical Report 7

An approach to introducing computing to practicing science and mathematics teachers.

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TECHNICAL REPORT SERIES

The Technical Report Series of the Science and Mathematics Education Centre (SMEC) was initiated in 1980. The series provides a mechanism for communicating results of research and developmental projects to others in science and mathematics education. The reports include details and information not often included in published papers.

The Science and Mathematics Education Centre was established in 1978 as a separate unit within the Division of Engineering and Science. The functions of the SMEC are to serve science and mathematics educators within the community and within WAIT by acting as:

- a centre for graduate studies in science and mathematics education;
- a focal point for research and development activities in science and mathematics education;
- an information and dissemination centre for science and mathematics education literature and resources;
- a focal point for contact between science and mathematics educators, professional organisations, industry personnel and the general community.

The SMEC offers two graduate courses, the Graduate Diploma in Science Education and the Master of Applied Science (Science Education). Both courses are primarily intended to enhance science and mathematics educators' professional development. This is achieved in the Graduate Diploma through the provision of courses of study that include science and/or mathematics and science and mathematics education. The Master of Applied Science (Science Education) is examined entirely by thesis. Research projects and theses undertaken by graduate students emphasize the applications of science education, mathematics education and computer education relevant to their professions.

Information concerning the Technical Report Series can be obtained from the Head of the Science and Mathematics Education Centre.

Dr John Dekkers
Head
SCIENCE AND MATHEMATICS EDUCATION CENTRE

AN APPROACH TO INTRODUCING COMPUTING TO PRACTICING SCIENCE AND MATHEMATICS TEACHERS

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INTRODUCTION

In recent years the rapid advances in computer technology together with a widespread availability of computers has resulted in a proliferation of the application of computers to a variety of professions in fields ranging from education to medicine (de Ferranti, 1975). In many situations the computer is used by persons who do not have strong backgrounds in computing but who may wish to increase their expertise in this area. The needs of these persons are rarely identical; for example, a research chemist may require skills in interfacing computers with analytical instruments, while secondary teachers may need skills in using computer-assisted learning packages in the classroom.

The diversity in the special needs of different professional groups with respect to computing poses problems for tertiary institutions offering professional development programmes. The limited sets of experiences that can be provided in any one computing course cannot generally meet the diverse range of needs and account for the different backgrounds of graduate students from a variety of disciplines. One means of overcoming this problem is to develop optional units in computing which are intended to meet the needs of a specific student group. Another means of addressing the problem is to revise existing course units to include aspects of computing. Each of these two approaches to meeting specific computing needs of professionals has particular strengths and weaknesses. This paper describes how aspects of computer science and computer education have been incorporated into a graduate professional development programme

for practising science and mathematics teachers; this has been accomplished by incorporating optional units and revising existing units in order to accommodate for varying backgrounds, needs and interests of students.

NATURE OF THE PROGRAMME

The Science and Mathematics Education Centre (SMEC) at the Western Australian Institute of Technology offers two graduate courses — The Graduate Diploma in Science Education and The Master of Applied Science (Science Education). The Graduate Diploma is completed by course work and a project over a two year period by part-time study. The project may involve curriculum development, curriculum evaluation or empirical research. The course work for the Graduate Diploma has three components: 1) science/mathematics education units offered by the SMEC which involve indepth treatment of the teaching and learning of science/mathematics; 2) science/mathematics/computing optional units offered by the teaching schools of the Division of Engineering and Science which involve further study in the students discipline area at the graduate level; 3) education optional units offered by the Faculty of Education, which involve study of more general aspects of education. These components have weighting in the ratio 3:2:1 respectively. The Graduate Diploma is a prerequisite to the Master's degree which is examined by thesis in an area of science/mathematics/computing education.

Students in the programme are practising teachers from primary, secondary, technical, nursing and tertiary education. Consequently, their academic backgrounds and teaching experiences are diverse and frequently quite substantial. This diversity is accommodated through the provision of six units of study within the graduate programme, namely, biology education, chemistry education, physics education, integrated science education, computer education and mathematics education.

Students' diverse academic backgrounds and interests are reflected in their interests and expertise with respect to computing and computer education; three distinct groups of students can be identified. The largest group consist of science/mathematics teachers with interests and expertise in an area other than computer science/computer education. A further but smaller group comprises science/mathematics teachers who wish to develop expertise in computer education. Another group in the programme, the smallest group, comprises computer education specialists who wish to pursue further studies in computing and computer education.

THE COMPUTING COMPONENT

In order to cater for the students in each of these groups, three computing components of the graduate studies programme have been developed. One component deals with computer science and computer education; another component concerns the computer as a tool in educational research; a third component deals with research and evaluation in computer education.

Computer Science & Computer Education

Approximately one third of the coursework of the Graduate Diploma involves students pursuing graduate studies in an area of science or mathematics or computing. Those students taking a computing/computer education emphasis in the course can select computer science units from the Graduate Diploma in Computing offered by the School of Mathematics and Computing. The units cover all areas of computer science from programming to computer architecture. A further one-sixth of the coursework in the Graduate Diploma course involves further studies in education whereby students select units from the graduate courses offered by the Faculty of Education. Students emphasising computer education select computer education units which cover areas such as basic programming, computer assisted learning and instructional design in computer education.

The Computer as a Tool in Educational Research

The increased use of computers in science and mathematics education research deem that it is essential for graduate students to acquire the basic skills necessary for data collection techniques and for data analysis. Since these basic skills are essential to all students, the computing component is included in the first two core units which are concerned with "Foundations and Issues" and "Research and Evaluation" in science and mathematics education. One in four formal class contact hours has been used for computing in each of these units. The content for this part of the course is presented in Table 1. In the "Foundations and Issues" unit, students are taught basic

TABLE 1

BASIC COMPUTING SKILLS FOR PRACTICING EDUCATORS

1. Using the Computer
   - introduction to computing hardware/software
   - use of terminals and peripherals
   - operating system commands

2. File
   - creation
   - editing
   - manipulation

3. Data Preparation
   - coding
   - batch/interactive input

4. Data Analysis
   - test marking and analysis
   - overview of statistical packages
   - using of SPSS

5. Computer Assisted Learning
   - CAL coursework
   - author languages

computing. In the "Research and Evaluation" unit, computing skills are directly related to aspects of research methodology discussed in the unit; for example, when discussing data analysis of a pre-test post-test in quasi-experimental design, students learn how to write appropriate SPSS programmes for mean difference testing.

The computing component of the above units is not designed to bring students to a universally high level of computing skill. The experience is designed to provide the fundamentals that will enable each student to efficiently pursue his or her own research and/or evaluation work in science/mathematics/computer education. Using the computer in a practical research and/or evaluation project also enables graduate students to gain an increased appreciation of computers and computing and to incorporate aspects of computing in their own professional activities.

Research & Evaluation in Computer Education

One of the major goals of the science/mathematics education component of the Graduate Diploma is to enable students to competently conduct educational research and evaluation studies. This preparation is essential for students entering the Masters Degree upon completion of the Graduate Diploma. The units in the science/mathematics component address basic issues, trends and theoretical foundations of science/mathematics education and research and evaluation methodologies. In addition specialist units pursue these aspects in further depth with particular reference to the specific teaching area. For example, the

specialist unit in computer education covers application of current learning theories and models; teaching computer education; curriculum and instruction design; current trends in and methodologies used in research and evaluation in computer education; and issues in the teaching and learning of computer education.

The project requirement of the Graduate Diploma enables students taking a computing emphasis to conduct a small scale research or an evaluation study or a curriculum development project in the area of computer education utilizing the skills developed in the earlier units. Some examples of studies in computer education presently being undertaken at the Centre include: A case study of the implementation of a computer in a rural school; The determination of priorities for the allocation of resources in secondary schools; A review of assessment of practices in introducing programming in lower secondary classes; and The development of a computer science course for secondary schools.

STRATEGY FOR TEACHING COMPUTING SKILLS AS A TOOL IN EDUCATIONAL RESEARCH

From the authors' experience graduate students appear to be easily turned off if their learning experiences are not compatible with their learning styles and perceived needs. Learning computing skills appears to be facilitated by successful encounters with the computer while working on relevant and realistic tasks. For busy professionals studying on a part-time

basis, unsuccessful encounters can be frustrating and can lead to the development of negative attitudes towards computers and computing. Subsequently, computing experiences are provided that are relevant to specific needs, presented in a meaningful manner and compatible with the abilities of the students.

In the design of the Graduate Diploma, sufficient flexibility is allowed in learning experiences to enable each student to pursue his or her own goals. Subsequently, many of the computing problems tackled by the students are relevant to their own particular educational situation and are not solely prescribed by the instructor. Computing tasks are generally presented in a stepwise fashion in the introductory unit to ensure that students do not become frustrated by being unable to capably function with specific commands. During initial experiences, the pace of learning computing skills is arranged to allow the person with no background to adequately assimilate ideas. Persons in the group with greater expertise are encouraged to help others; even those students with some background in computing appear to find much value in the sessions.

In general, practicing science and mathematics teachers in the course seem to gain more from experiences that have an emphasis towards practice and function rather than with an emphasis on computing skills that are not clearly related to the solution of problems that are real in their world. To assist with these initial computing experiences, we have developed two booklets -

Batch and Interactive Computing on the DEC system 10 (Dekkers & Adeljou, 1980a) and Instruction Manual for the Use of Mark Sense Cards & Multiple Choice Test Marking System (T-score) (Dekkers and Adeljou, 1980b).

CONCLUDING REMARKS

Computing skills are becoming an increasingly important facet of the knowledge required by both undergraduate and graduate students in science and mathematics disciplines as well by graduate students in science/mathematics education. Consequently, it is important that tertiary institutions respond to this need so that all students, not just students of computing, are better able to develop skills which are useful for their professional activities in a computer dominated society.

One area that deserves close scrutiny by educators is the development of suitable methods to incorporate computing in existing and in new graduate programmes. This paper has described two means for incorporating computing into a course for science and mathematics teachers which we believe has applications in other areas of graduate study — incorporating optional units and revising existing units to accommodate computing. The means described in this paper have provided a successful introduction to computing for students unfamiliar with computing and has served as a basis for more intensive and indepth studies in the more traditional computer courses for those students who desire such experience. Those students who commenced their studies in the Graduate Diploma with prior

knowledge of computing have acted as facilitators for their colleagues learning computing. Such experiences have been valuable for these students in that it has provided them with insights associated with teaching computing.

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